REMARKS

This responds to the Office Action mailed on March 8, 2005.

No claims are amended, claims 4, 12, 17, 25 and 33 are canceled, and no claims are added; as a result, claims 1, 2, 5-10, 13-15, 18-23, 26-31, 34–37, 51, 52 and 54-56 are now pending in this application.

Information Disclosure Statement

Applicant submitted Supplemental Information Disclosure Statements and 1449 Forms on October 1, 2003; February 9, 2004; September 29, 2004; and November 12, 2004. Applicant subsequently submitted copies of these 1449 Forms with the response filed February 9, 2005. Applicant respectfully requests that initialed copies of the above-referenced 1449 Forms be returned to Applicant's Representatives to indicate that the cited references have been considered by the Examiner. The Examiner is invited to contact Applicant's representative with any questions concerning these Information Disclosure Statement, or if the Examiner should need additional copies of the 1449 Forms for consideration.

§103 Rejection of the Claims

Claims 1-2, 4, 6, 14-15, 17, 19, 51-52, and 55-56 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma (U.S. 6,207,589) in view of Park (U.S. 5,795,808). Applicant respectfully traverses this rejection.

Ma apparently discloses a transistor having a metal oxide gate dielectric formed of either Zr or Hf alloyed with approximately 25% of a trivalent metal such as aluminum, or lanthanum. The metal oxide is formed by either sputtering in an oxygen ambient, cosputtering in an oxygen ambient, chemical vapor deposition in an oxygen ambient, or evaporation and annealing in an oxygen ambient. The final structure has an interface barrier 62 having a thickness 64 of typically 2-5 angstroms. The interface barrier 62 is formed of either silicon nitride or silicon oxynitride (see col. 2, line 17 and col. 6, line 9 and figures 12 and 13).

Park is used in the Office Action to show that sputtering and evaporation are art recognized equivalents. Applicant respectfully disagrees with Examiner's statement that sputtering and evaporation are equivalent operations. As noted in figure 2b and 2c, and as

discussed in the specification at least at page 3, line 10 to line 24, sputtering causes physical and radiation damage to the substrate surface and structures that cannot be repaired by present annealing methods. Thus, Applicant submits that devices that need low leakage currents cannot use sputtering for depositions on sensitive surfaces such as the channel regions of a MOSFET. Therefore, since the result of the two different deposition methods have different results, and since the use of sputtering in the devices of the present patent application would result in an inoperative device, then the two methods are not equivalent for the purposes of the present subject matter.

Applicant respectfully submits that whether or not Park is combined with Ma, the result is a different method and a different structure than the present patent application. As discussed above, Ma has a final structure that has a nitride interface barrier 62 between the gate dielectric 56 and the channel region 52 (see figures 12 and 13). Thus the cited references do not suggest "*... a metal oxide layer directly contacting the body region ...*", as recited in independent claim 1. Further, Applicant submits that Ma discloses an alloy that has approximately 25% of a trivalent metal such as aluminum, and thus cannot suggest a "*...substantially single element metal layer directly contacting the body region ...*", as recited in independent claim 1. Finally, Applicant submits that Ma apparently discloses the use of what is known as reactive sputtering where the ambient is oxygen, and thus cannot suggest "*...evaporation depositing a ...single element metal ...*", as recited in independent claim 1. The cited references deposit either a dielectric or an alloy or both.

The other independent claims of the present patent application have similar language to that quoted from claim 1 of the present patent application. For example independent claims 14 and 51 of the present patent application recite "*... evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table...*", and independent claim 55 recites "*...electron beam evaporation depositing a substantially amorphous and substantially pure zirconium layer directly contacting the body region ...*", which features are not suggested in any combination of the cited references as noted above.

The dependent claims are believed patentable at least as depending from patentable base claims, as discussed above. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 5, 7, 18, and 20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Yano (U.S. 5,810,923). Applicant respectfully traverses this rejection.

Ma and Park have features that have been discussed above. Yano is apparently used in the outstanding Office Action to show that the deposition temperature range and the use of atomic oxygen are known.

Applicant submits that there is nothing in the cited reference of Yano that cures the above noted deficiencies in the combination of Ma and Park with regard to independent claims 1 and 14. In particular, the cited references, whether taken alone or in any combination, neither describe nor suggest at least the combination of claimed features of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer to form a metal oxide layer directly contacting the body region ...*", as recited in independent claims 1 and 14. The cited references do not describe or suggest a single metal directly on the body region or oxidizing the metal.

The dependent claims are believed patentable at least as depending from patentable base claims, as discussed above. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 8, 21, and 54 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park and further in view of Moise (U.S. 6,211,035). Applicant respectfully traverses this rejection.

Ma and Park have features that have been discussed above. Moise is apparently used in the outstanding Office Action to show that oxidizing in a krypton and oxygen mixed plasma is known. The outstanding Office Action states on page 6 that the cited Ma reference "teaches annealing in an oxygen plasma including inert gases such as argon, and nitrogen". Applicant

respectfully disagrees that Ma teaches oxidation of an evaporated metal layer. In the indicated section of the Ma reference, the object being annealed is a CVD deposited dielectric and not a metal layer, and certainly not a single metal layer since there are at least two major metal portions of the dielectric. Ma is annealing defects in a dielectric layer and is not oxidizing a metal layer. The Ma reference discloses heating a sample in an ambient that includes a vacuum, or various gases, or a low pressure oxygen plasma, but does not suggest an inert gas plasma or a mixed gas plasma.

Whether or not Moise teaches the use of a mixed Kr/O_2 plasma for oxidation of a single metal as recited in the claims, the addition of Moise to the suggested combination of Ma and Park does nothing to cure the above-noted deficiencies in the combination of Ma and Park with regard to independent claims 1 and 14. In particular, the cited references, whether taken alone or in any combination, neither describe nor suggest at least the combination of claimed features of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer to form a metal oxide layer directly contacting the body region ...*", as recited in independent claims 1 and 14. Independent claim 51 recites "*... evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table...*". Applicant submits that no combination of the cited references describes or suggests the above-noted claim features.

The dependent claims are believed patentable at least as depending from patentable base claims, as discussed above. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 9-10 and 12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park and further in view of Moise. Applicant respectfully traverses this rejection.

Independent claim 9 is neither described nor suggested by the combination of references at least because the feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam*

evaporation ..." is not found in any of the cited references. Ma has an interface barrier, and the other references are not seen as providing any teaching to cure the deficiencies of Ma. Therefore, independent claim 9 is believed patentable over the suggested combination of references.

The dependent claims are believed patentable at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park and Moise, and further in view of Yano. Applicant respectfully traverses this rejection.

The cited reference of Yano is used in the outstanding Office Action to show that zirconium may be deposited at 300 to 700 °C. The cited reference of Yano is not seen as providing a cure for the deficiencies of the combination of Ma, Park and Moise as discussed above with reference to claim 9, from which claim 13 depends. In particular, independent claim 9 is neither described nor suggested by the suggested combination of references at least because the feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation ...*" is not found in the references. The reasoning is similar to that given above.

Dependent claim 13 is held to be in patentable condition at least as depending from a base claim shown above to be patentable over the suggested combination of references. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 22-23, 25, 27, 30-31, 33, and 35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park and further in view of Maiti (U.S. 6,020,024) and the "admitted prior art"("AAPA," pages 1-4). Applicant respectfully traverses this rejection.

Ma and Park have been discussed above. Maiti has been discussed in previous responses and apparently discloses a high dielectric constant metal oxide layer on a silicon nitride layer grown on the body region of a semiconductor device. The silicon nitride layer 14 is intentionally formed by Maiti by ion implantation of nitrogen, thermal nitridation of an oxide layer by ammonia, nitric oxide, nitrous oxide, or plasma/thermal processing. The nitride layer 14 is

apparently an integral and essential feature of Maiti, as seen from the discussion in column 3 of Maiti, and from the statement that the nitride "layer 14 will not have as much of an adverse effect on the overall effective gate oxide thickness (EOT) as the prior art SiO_2 processes" (*see* Maiti at column 3, lines 24-26). Applicant respectfully submits that a person of ordinary skill in the art would therefore understand that nitride layer 14 is an important part of the structure taught in Maiti. Maiti is used in this rejection to show that it is known to use high k metal oxides for transistors. The "AAPA" is used to show that processor chips are known.

As noted above with respect to the prior rejections, Ma has an interface barrier 62 of either silicon nitride or silicon oxynitride typically 2-5 angstroms thick (see col. 2, line 17 and col. 6, line 9 and figures 12 and 13). Maiti also has a nitride layer below the metal oxide. Thus the suggested combination fails to describe or suggest at least the claimed feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table* ...", as recited in claims 22 and 30.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 26, 28, 34, and 36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Maiti and the "admitted prior art" ("AAPA", pages 1-4), and further in view of Yano. Applicant respectfully traverses this rejection.

Yano is used in this rejection to show that zirconium deposited at 300-700 °C is known. Yano does not cure the deficiencies of the combination of Ma. Park, Maiti and "AAPA" with respect to base claims 22 and 30 as discussed above. Specifically, Yano does not help with the failure of the suggested combination to describe or suggest at least the claimed feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table* ...", as recited in claims 22 and 30.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 29 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Maiti and the "admitted prior art" ("AAPA," pages 1-4), and further in view of Moise. Applicant respectfully traverses this rejection.

Moise has been discussed above and is apparently used in this rejection to show that "oxidizing a metal layer with inert gases such as argon or krypton (column 12 lines 23-24)" is known. Applicant respectfully submits that it is not possible to oxidize using inert gases as suggested by the rejection, and that at the suggested location the Moise reference is disclosing chemistries for a reactive ion etch of the silicon dioxide layer.

Moise fails to cure the deficiencies of the combination of Ma. Park, Maiti and "AAPA" with respect to base claims 22 and 30 as discussed above. Specifically, Moise does not help with the failure of the suggested combination to describe or suggest "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table ...*", as recited in claims 22 and 30.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney David Suhl at 508-865-8211, to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

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By their Representatives,

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 7 day of June, 2005.

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